City of Corvallis Salmon Response Plan

Chapter 6. Pathways/Effects Analysis

Prepared for:

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Disclaimer

The authors have attempted to replace all references to Squaw Creek with the creek's new name, Dunawi Creek. This includes replacing the creek's full name as well as changing Squaw Creek Reach reference labels to indicate Dunawi Creek.

Table of Contents

CHAPTER 6. PATHWAYS/EFFECTS ANALYSIS

INTRODUTION

This chapter describes the combined baseline conditions and pathways/effects data for identifying the geographic distribution and the degree of impact that City services and citizen behavior have on Chinook salmon habitat. It discusses these activities and their effects in terms of their spatial (geographic distribution), temporal (time) and intensity (concentration) scales.

The chapter relies on three sources to identify impacts. First, it relies on an approved methodology for evaluating city activities and their impact on chinook salmon habitat in the project area (see Appendix 4 for a copy of the Technical Memorandum, *Methodology for Pathway Evaluation*). Second, it draws on a weighted database that has been created to analyze city activities and their impacts on Chinook salmon habitat and water quality. The weighted database contains approximately 4,300 records that cover the range of city activities that can impact habitat (see Appendix 5 for a CD with the entire database). Finally, it relies on information and baseline conditions work from Phase I of the ESA study (see *Baseline Habitat Evaluation and Evaluation of the City Activities*, February 2002, in Appendix 6 and NOAA Fisheries letter response in Appendix 7).

The methodology for this analysis compares and ranks activities as to their relative impact on Chinook salmon habitat and water quality. This approach provides a mechanism for evaluating the effects of City activities and events and citizen behavior at any geographic level desired by the City (e.g., reach, stormwater basin, citywide, and UGB). It allows for a comparative ranking of the effects to identify different degrees of impact, and it provides a framework for fiscal analysis. This analytic framework can help the City allocate its limited financial resources for habitat rehabilitation and recovery, and water quality improvements.

Given the number of records and the many ways of organizing and analyzing the data, this discussion confines itself to broader spatial and time scales rather than to specific impacts. It summarizes the results of the analysis and identifies some of the major impacts to Chinook salmon habitat identified in the database and the Phase I analysis. Using this approach it is possible to draw a number of more generalized conclusions about City activities and their impact on Chinook salmon habitat.

WEIGHTED DATABASE KEY ELEMENT DESCRIPTION

Database Set Up

The database is set up to evaluate impacts that City activities and citizen behavior have on Chinook salmon habitat and water quality. The structure of the database and the weightings is based on actual, not hypothetical, use of the streams by Chinook salmon. Since Chinook salmon use of Corvallis streams is very limited, it bears repeating that the findings of Phase I of this project provide the setting for the database structure and impact analysis.

The baseline analysis in Phase I indicates that streams in Corvallis do not now, or in the past, contain the elements Chinook salmon require for spawning and rearing (see Appendix 6 for the *Baseline Habitat Evaluation and Evaluation of the Impacts of the City Activities* February 2002, and Appendix 8 for the *Technical Memorandum on Chinook Salmon Habitat in the Upper Willamette River ESU* 3/3/03). Chinook salmon potentially gain access to and may use the lower reaches of some of the streams for refuge during high water flows in the Willamette River. Juvenile Chinook use the Willamette River for rearing and movement. Adult Upper Willamette River Spring Chinook salmon use the river as a migration corridor. Neither juveniles nor adults use the upper reaches of Corvallis streams.

Therefore, while Chinook salmon may gain temporary access to Corvallis streams, the streams provide none of the elements necessary for spawning and rearing. Consequently, the results of the weightings analysis focus mainly on impacts to water quality, which can realistically influence Chinook salmon habitat downstream, outside of the project area.

The analysis in this report focuses on the predetermined stormwater basins the City uses for its stormwater management program. By doing so the City can link activities and their weighted impacts in this study to other important City programs, such as control of stormwater runoff impacts to water quality. The advantage of piggybacking onto the stormwater basins and the reaches within them makes it possible to define areas where natural processes act in a similar fashion and City activities have similar impacts. Such organization also allows for the identification of “fixes” that can, where possible, be integrated with other ongoing City activities to improve watershed health.

Another advantage of the weighted database analysis is the incorporation of land use/zoning designations by reach. Land use can significantly impact Chinook salmon habitat. Fortunately, zoning characteristics determined to have negative impacts on habitat may be modified or changed to incorporate land use or development activities, mitigations, or even best management practices (BMPs) to help preserve or restore riparian function and water quality in the Willamette River and its Corvallis tributaries.

Pathway Scoring and Weight Score Assignment

Weight scores are based on five factors. They are the four pathways as defined by NOAA Fisheries and a fifth factor that accounts for proximity of a City activity to a city stream. Citizen behavior can also impact Chinook salmon habitat and water quality, but it is evaluated as a separate category. The database evaluates each activity or event for the above pathways, contaminants, impervious surface, buffers and barriers, and weights City activities according to its location inside or outside a 200-foot stream corridor.

The following sub-sections describe the pathways and score values assigned to each pathway. Values vary depending on the pathway. Some pathways exhibit little or no variation while others have significant variation.

Contaminant Pathway

Weighting factors for the contaminant pathway do not vary by stream location. Contaminants are considered to have relatively the same impact on water quality regardless of the location at which the contaminant enters the stream. Contaminants in the water produce direct effects, through toxicity to one or more life stages of the fish or other elements of the food web, or indirect sub-lethal effects on growth and vitality.

The difficulty comes in separating these sub-lethal effects from normal Chinook salmon population variation, as well as normal variation that occurs within and between seasons. NOAA Fisheries regards sub-lethal effects as highly important to the long-term survivability of the Chinook salmon population, as they diminish lifetime reproductive output, usually through effects on growth, reproduction, sensory or motor functions, or food supply. Though Chinook salmon rarely inhabit Corvallis streams (except the Willamette River), if at all, and only during peak flow times, the impacts resulting from City actions are considered indirect and citywide in their spatial distribution. Because of the above-mentioned difficulty in separating sub-lethal effects from normal variation, sub-lethal effects are included in the overall contaminant score.

Impervious Surface Pathway

The impervious surface pathway weighting values vary widely because of the variability of existing impervious surface in Corvallis. The lower reaches of Corvallis streams, those closest to their confluence, where there already exists a high percentage of impervious surface are assigned lower negative weight values for City activities than upstream reaches, where there is a much lower percentage of impervious surface. This is due to the fact that additional impervious surface in a lower reach would not impact Chinook salmon habitat as much as in a reach with little or no impervious surface (i.e., areas with little development).

Buffer Pathway

The weightings for the buffer pathway follow a similar rationale as that for the impervious surface pathway. Reaches where buffers are already narrow tend to have lower weightings than reaches with existing wide buffers.

The importance of the buffer or stream corridor characteristics pathway varies. Changes in the riparian condition (e.g., shade, LWD, impervious surface, bank stability, etc.) can result in an increase in instream erosion and an eventual loss of habitat structure and diversity. The increased hortonian (overland) water flow that can happen with a reduced buffer can contribute more sediment and contaminants to streams. Other riparian conditions such as infiltration can be impacted with diminishing buffer size.

The presence of LWD diminishes with lowered riparian connectivity. A buffer zone with no large trees contributes no LWD to the stream channel. Buffer values generally increase with decreasing stream gradient, as do vegetation mosaics.

In the case of Corvallis, the most important buffer functions are to maintain water quality. Buffer community structure has less importance. Recent information suggests that the historic riparian buffers in the lower reaches of Dixon, Dunawi, Oak, and Sequoia Creeks consisted of prairies, with the upper, higher elevation areas containing the more dense oak and conifer forests. Width typically increases in a downstream direction, as floodplain size increases. Research suggests that the riparian buffer width in these areas has actually increased over what existed historically, at least in terms of trees and shrubs (S. Gregory, personal communication [pers. comm.] 2003).

The lower reaches of Dixon, Oak, and Sequoia Creeks contain the highest negative riparian buffer scores, as they contain the highest concentration of urban development and activities. The large concentration of urban activities has converted the natural buffer to impervious surface, which has narrowed the natural buffer corridor width.

Urban development and road crossings also cut the continuity of the riparian buffers, negatively influencing their function, and potentially restricting free movement of water along the corridor and decreasing vegetation diversity. Dunawi and Dixon Creeks provide good examples of the importance of continuity. Both creeks have similar types of development activities occurring in the upland areas. Despite this, on Dixon Creek Reaches 1, 2, and 3 the riparian buffer consists of a single row of trees for most of its length, as opposed to the more extensive riparian buffer on Dunawi Creek. The change from prairie and gallery forests to treed areas increases the shading of the area, but decreases the mosaic or buffer community structure, simplifying its composition and changing it from native to predominantly non-native species.

The presence of urban development within the stream corridor and buffer area generally decrease shade in the riparian zone, which can result in higher stream temperatures. Buffer areas with shrubs or young trees provide little shade, grasses even less, with lawns providing none. While the thin riparian buffers may provide some shade, all reaches suffer from high temperatures by August. These temperatures likely resemble historic trends as the increased riparian tree cover in the lower reaches of creeks like Oak and Dixon, which are not believed to have existed prior to urban development, balances the loss of historic, low temperature groundwater inputs.

This potential for temperature increase is less important in upper stream reaches as higher gradients move water more rapidly through the system decreasing residence time and exposure to the sun. In the lowland reaches, water remains in the stream longer, and may reach temperatures too high for salmonids.

While almost any bank vegetation provides a buffer and protection against erosion, the quality of this protection can vary. In the incised lowland reaches of the streams, the presence of trees in the riparian corridor provides little bank protection, despite their extensive root systems. Grasses play an even smaller role for bank protection, although both do provide some protection against erosion from overland flows. The critical reaches to protect remain those highest up in the systems, as these have not yet incised to the degree of the lower ones. Reducing the intensity and magnitude of flows resulting from stormwater inputs in the higher reaches of the system will serve to slow the process of incision in the lower reaches. Historical analysis, and the nature of the Corvallis area soils and topography, all suggest the inevitability of incision by most streams. Despite this, the lack of incision on Dunawi Creek has produced a viable riparian corridor and buffer width in the non-urbanized reaches, with some streamside wetlands remaining in the upper areas.

Barrier Pathway

Barriers can prevent fish passage and access as well as block the development and/or maintenance of salmonid habitat. Natural processes and human activities can both create barriers. Debris jams, waterfalls and seasonal downwelling (a stream that goes underground) are examples of natural barriers. Dams and culverts are examples of barriers created by human activity. Depending on the barrier, fish passage access may be restricted seasonally or permanently. The concern for the City of Corvallis is the degree to which human-made barriers in the streams negatively impact Chinook salmon passage and habitat.

The evaluation and scoring of barriers depends on their location and the degree to which they prevent passage or access. The barrier pathway is scored by the following process. Barriers that are located in lower reaches or at a stream's confluence are considered to have a greater negative impact because they prevent access or passage to a larger part of the stream's habitat than those in higher reaches. Therefore, lower stream barriers are assigned a higher number. Secondly, barriers that permanently prevent passage and access are considered to have a greater negative impact and are scored higher than seasonal barriers (e.g., barriers to passage and access during low flow). This is important where Chinook salmon have been known to seek off-channel refuge in Dixon Creek during high water flow in the Willamette River.

Stream Corridor Distance Factor

A fifth factor is included in the weight scores to account for differential impacts of City activities and events and citizen behavior on Chinook salmon habitat related to distance from a stream. Activities and behaviors occurring within the study area (200-foot corridor extending upland from the top of the bank on each side of the stream) as opposed to the same activities and behaviors occurring outside the corridor are considered to have a higher potential habitat impact.

There are three reasons for this difference. First, activities and behaviors occurring within the stream corridor influence listed fish and their habitat directly without the need of a transport mechanism or pathway to convey the impact to the stream. Activities and behaviors occurring outside the corridor often require intervention of a transport mechanism or pathway such as the stormwater system to convey the impact to the stream.

Second, activities and behaviors within the stream corridor can directly affect riparian buffer characteristics, which are critical to maintaining the health of Chinook salmon habitat. The further the activity or behavior is from the stream, the less likely it can impact the riparian buffer characteristics.

Third, NOAA Fisheries recognizes that there is a spatial relationship between urban oriented activities and impact to salmonid habitat. NOAA Fisheries cited in their preamble to the proposed 4(d) Rule a 200-foot corridor or buffer from streamside within which urban activities could potentially have a greater impact on salmonid habitat. NOAA Fisheries has gone on to state that the most "effective way to ensure PFC [Properly Functioning Condition] is to manage MRCI [Municipal, Residential, Commercial, Industrial] development activities in riparian areas so that their impacts on habitat functions are minimal at the streamside, but may gradually increase with distance from the stream." (Federal Register/Vol. 65, No. 132, pg. 42462).

The City used the 200-foot corridor width proposed by NOAA Fisheries as the riparian study area boundary, simply to provide consistency with the guidance. The presence of this area precludes no activities, but simply defines an area that NOAA Fisheries will scrutinize heavily in their analysis of any plan seeking ESA 4(d) Rule compliance. Consequently, weight scores are adjusted to increase the impact that an activity or behavior can have if it is located within the corridor. The weighting factor within the corridor increases the numerical score by a multiple of three.

Urban Activities and Impacts

The four pathways and the location factor are important in determining an activity's impact on water quality, but they do not describe the activity itself. They are external factors acting as a pathway to or a location relative to the stream. When considering the activity itself three additional factors are used to determine an activity's impact and the degree of impact it has relative to another activity. The three factors are magnitude, periodicity and intensity.

Magnitude

Magnitude refers to size or spatial extent of an urban activity. Size plays an important role in the level of impact on water quality; the larger the area the activity covers, the greater potential for impact. For example, discharge from a single stormwater outfall located in an upper reach of a Corvallis stream would not have the same impact on Chinook salmon habitat and water quality as the combined impact from all stormwater discharges.

Magnitude of an activity is rated or scored according to the area of its spatial distribution. The smaller its distribution, the smaller its impact on Corvallis streams and therefore the smaller the score. The smallest magnitude is an activity with a single or point location. This is scored a One. Activities with the biggest spatial distribution are considered to have an impact basin-wide and are scored a Four.

Among City activities that may have the greatest impact on Chinook salmon habitat due to magnitude are those related to land use and development. The wide spatial distribution associated with different types of development and the requirements set forth in the land development code (LDC) affects large areas of the City.

For example, the urbanizing upland areas in Oak Creek, Dunawi Creek South Fork, and Dixon Creek Middle and West Fork are beginning to display similar impacts as their lowland reaches – incising due to increasing water volume and velocity, removal of buffer vegetation, and sediment transfer. Widespread residential development has added and is adding significantly to the amount of impervious surface in these upper reaches. The magnitude of this development has a significant impact on the potential Chinook salmon habitat and water quality. Activities in this area receive higher negative scores due to the presence of increased residential development and associated increases in impervious surface. The higher slope of the areas in question also exacerbates the negative contributions to flow from impervious surface and stormwater runoff. Further removal of the buffer in these areas increases the potential for erosion.

The magnitude of impervious surface from urban development and subsequent stream channel alteration in the lower reaches has significantly influenced water quality. The lower reaches of all streams contain high levels of impervious surface and associated runoff. The percentage of impervious surface in the lower reaches of both Dixon and Oak Creeks exceeds 70 percent.

Periodicity

The frequency and duration of an event or activity can exert considerable influence upon the ability of the stream system to rebound from disturbance and remain in properly functioning condition for Chinook salmon habitat. Historic habitat-forming processes typically consisted of single-event or episodic occurrences. For instance, a tree falling into a creek is a single event, while flooding (e.g., 2-year 10-year, 100-year, etc.) and seasonal flows are considered episodic events. The periodicity of their occurrence allows the stream time to react and rebound.

Activities are rated according to their periodicity using a One to Four scale. Single event activities are those with the shortest period and are rated One. At the other end of the spectrum are chronic events or events that have a continual impact on the stream system. Chronic events are rated a Four. In between are episodic (occur with no predictability) and periodic events (occur at predictable intervals, separated in time) that reflect increasing impact to water quality. They are rated Two and Three respectively.

Many City activities and citizen actions, however, are not single or periodic events. They fall into the chronic category of events that occur on a continual basis, such as regularly scheduled City maintenance activities for transportation, utilities, and parks. The chronic nature of these activities may actually apply more stress on the ability of the system to react and rebound. Instead of the system reacting to single or episodic events, the watershed is constantly receiving inputs. The reaction to chronic inputs can have a very different impact on a watershed than single, episodic or even periodic events.

Intensity

Intensity refers to the strength or concentration of the activity's or event's contribution to the impact. The higher the intensity or contribution that the activity or event has on the water quality, the greater the intensity score. For example chemicals in herbicides, pesticides or fertilizers can vary in concentration. If they enter the stream their impact will depend on their strength (in this case toxicity to Chinook salmon) and concentration. Stormwater discharge can also vary in intensity. A stormwater outfall along a creek could have a low, medium, or high intensity impact depending on the volume of water and the contents in the runoff.

A rating of One to Three is used to score the intensity factor. Events or activities that are considered to be of low intensity would be scored a One, while events or activities of high intensity would be scored a Three. An event or activity of medium intensity would be scored a Two.

Ratings

Three ratings were applied to City activities and events, depending on their magnitude, timing, and intensity. A few examples should illustrate how the rating process was conducted.

One example that demonstrates the rating process is park maintenance and herbicide use. The City has a small program that uses primarily backpack sprayers but also uses aerosols and granular products. Non-selective post emergent and non-selective pre-emergent herbicides are used periodically on developed landscape areas or on invasive plants, such as blackberries, along stream corridors. Application techniques and practices vary by site. Insecticides are predominantly used in treatment of structural and nuisance insects (e.g., sugar ants). While the Parks and Recreation Department goes to great lengths to minimize the environmental impact when maintaining their parks, they do still have a potential impact on Chinook salmon habitat and water quality. The following is the analysis used to rate maintenance activities and herbicide use.

- Magnitude: There are a number of parks located adjacent to Corvallis streams. While they are at specific or discrete locations along creeks, they are not a point location, but more likely cover several reaches. Therefore, the Magnitude is a reach (rate 3).

- Timing: Maintenance is conducted year-round, though different types of pesticides are used at different times of the year. Therefore the timing is chronic (rate 4).

- Intensity: Herbicides contain chemicals that may harm water quality and impact stream habitat. Therefore there is a potential for herbicides, should they enter the stream, to have a negative impact. Since herbicides are not used extensively and application techniques are adapted to site conditions, the intensity of the impact may vary, but generally it is considered low (rate 1).

A second example is stormwater runoff. In the LDC there are street standards that outline how development must handle stormwater runoff. Section 4.0.70 of the LDC defines minimum street standards for development. Stormwater drainage is required on temporary dead-ends. Alleys are required "in commercial and industrial districts to serve abutting properties unless other permanent provisions are approved by the Planning Commission or Director." New development and roadways increase impervious surface. The stormwater collection requirements, while important for keeping water off the roadway and other property, can increase the rate of runoff, concentrate pollutants, and interfere with groundwater recharge. If development is outside of the downtown area that is currently served by the City's combined stormwater and wastewater collection and treatment system, stormwater will likely end up being discharged directly to streams, which can have a negative impact on Chinook salmon habitat/water quality.

- Magnitude: The requirements apply throughout the City; therefore the magnitude is basin-wide (rate 4).

- Timing: The impervious surfaces will continue to exist for a long period. The timing is considered chronic (rate 4).

- Intensity: the intensity could be low or high depending on the location of the development and whether it is within the City's combined stormwater and wastewater collection and treatment system. If it is within the City's combined collection system the intensity is low (rating 1). If it is outside the collection system, it could be medium or high (rate 2 or 3).

SUMMARY OF IMPACTS – CITY ACTIVITY AND CITIZEN BEHAVIOR

The following summarizes the assessment of City activities and citizen behavior on Chinook salmon habitat and water quality in Corvallis streams. The assessment methodology is described in detail in Chapter 5 and the pathway data from which this summary is taken is provided on a Compact Disk (CD) in Appendix 5 and in the Phase I report (*Baseline Habitat Evaluation and the Evaluation of Impacts of City Activities, February 2002,* Appendix 6).

Since there are 4,375 records in the database it is not possible to provide specific details for all activities. This summary highlights the range and degree of impacts that City activities and citizen behavior have on Chinook salmon habitat and water quality and their geographic distribution. The activities examined include construction, operation, and maintenance of public infrastructure (e.g., utilities and transportation); parks and recreational facilities; land development; planning and policy development to provide infrastructure, transportation and park facilities; and citizen behavior.

Not all City activities negatively influence habitat and water quality. The City has made progress, through its LDC, toward requiring development to minimize the impact on surrounding natural resources. The City is also making progress toward preserving significant natural features identified by its Statewide Goal 5 work. Similarly, park facilities design for trails and pathways must minimize their impact on sensitive areas. This section focuses primarily on City activities that have negative outcomes, as these are the ones the City is developing proactive measures to avoid, minimize or improve in the future.

Stormwater

The stormwater collection and conveyance system has, perhaps, some of the greatest impacts on streams. Chief among these is the impact upon the streams by changing the hydrograph. The number of outfalls in the system and the relatively little on-site detention means that the greatest amount of stormwater acts as channelized flow into the streams, rather than percolating and entering the stream gradually through the groundwater system. Stormwater also serves as the conveyance or pathway for a number of other activities that can negatively impact habitat and water quality.

In Corvallis streams, some of the greatest negative impacts result from both increased erosion (in the upper reaches) and increased sedimentation rates in the lower. . Other pathway impacts include temperature changes, either through the warming of pooled water in detention facilities, or when stream flows are low during the dry season.

Other negative impacts from the stormwater system include the presence of barriers to fish movement caused by culverts (also a transportation impact) and the use of fertilizers, herbicides, and pesticides for vegetation control and maintenance along watercourses and in streams. Other contaminants, as well as sediments, get introduced into the system through the flushing process. Ditch maintenance also contributes to runoff and the introduction of contaminants.

The City has made progress in the reduction of some of these negative impacts. In the urban core, the City collects and treats most stormwater runoff. Stormwater is conveyed to the City's wastewater treatment facility where it is treated and discharged to the Willamette River. Outside of the urban core, stormwater continues to have a negative impact on the habitat and water quality in City streams.

Wastewater

Wastewater impacts include the introduction of contaminants and alteration of temperature. There are scenarios that could involve spills of wastewater and discharges that could introduce raw pollutants or treatment chemicals directly into the system (spills, overflows, leaking pipes, and pumping system failures). Effects of these discharges can have both direct toxic and sub-lethal effects on the fish themselves, though habitat impacts in these cases are likely to be negligible. New construction, such as the pipelines the City is planning along stream systems would have impacts related to the construction (increased erosion and sedimentation) and removal of riparian vegetation (the buffer) leading to increased temperatures from shading loss or increased sedimentation from bank erosion.

Drinking Water

The potable water system impacts occur as the result of raw water withdrawal from the Willamette River (instream habitat pathway) and its return to the system through the wastewater and stormwater systems, causing flow alterations and hydrograph changes. The introduction of contaminants through the effluent from backwashing of water filters, and flushing of pipes may prove critical, as does scheduling of any maintenance activities, as actions done during low water conditions do not benefit from dilution effects.

Transportation

Impacts from the transportation activities (e.g., improvements, new construction, the existing transportation network, and operation and maintenance) can have a significant negative impact on Chinook salmon habitat/water quality. Impacts may come from transportation improvements (e.g. the road design), their location in relation to city streams, increased traffic, increased maintenance and operation requirements, and from the construction activities themselves. Construction within the 200-foot study corridor has immediate impacts from increased erosion and sediment transfer to streams, increased impervious surface and resultant stormwater runoff-related changes to the hydrograph, and inputs of contaminants from the road surface. There can also be impacts to the riparian vegetation buffer continuity, composition, and width.

Construction outside the stream corridor may also have negative stream impacts resulting from the impervious surface and contaminant conveyance. Increasing stormwater runoff into the conveyance system will negatively impact instream habitat by altering the stream's hydrograph and introducing contaminants from the roadway surface (primarily petroleum based oils and grease). Greater impervious surface from roadway construction or widening will also reduce infiltration and increase runoff volumes and velocities. Similar impacts to the water quality result from the existing roadway network.

Operation and maintenance associated with de-icing roads, though rare in winter, introduces contaminants either directly into the stream system or into the stormwater system, with the same eventual destination. Roadside mowing decreases the ability of the vegetation to slow overland flow, by decreasing the surface roughness and to allow the stormwater to percolate. Bridge washing, maintenance, repairs, and painting can result in toxic or sub-lethal effects on fish or their food organisms.

Culvert cleaning and repair may introduce sediments into the stormwater or stream systems, causing an increase in total suspended solids. Overall operations and maintenance activities can have negative water quality impacts to Chinook habitat, though these activities are likely to be sub-lethal in nature.

Parks and Recreation

An examination of parks planning, design, construction and maintenance indicates two major pathways for impacts upon fish habitat – impervious surfaces and contaminants. Existing parks have an impact on habitat through design and maintenance. Design elements include trails, parking lots, park structures, landscaped areas, and playing fields. All of these can modify the existing conditions by increasing impervious surface and surface water runoff, with effects like those outlined for stormwater and wastewater. This can be a significant problem since the City has a number of park facilities adjacent to streams and rivers.

Since parks do not have stormwater collection, treatment and discharge facilities to handle runoff, the impervious surfaces, which can include turf fields, tend to produce hortonian flow into the streams. While sod areas may allow some stormwater infiltration, asphalt and heavily compacted soil, gravel and grassy surfaces still increase hortonian flow into the streams.

While the City Parks and Recreation Department has had some success in reducing the use of pesticides and fertilizers, effective substitutes have been difficult to find. The application of these chemicals can result in soil contamination, and eventually stream contamination through stormwater runoff. Maintenance actions utilizing these chemicals along the streams can have a direct negative effect, despite localized dispersal methods. Indirect effects occur as the result of sheet flow runoff from parts of the park system outside the stream corridor.

New parks may impact Chinook salmon and water quality through the same two pathways – impervious surfaces and contaminants. New construction also may commit a direct take on critical habitat (if NOAA Fisheries lists these streams as critical habitat) through placement in the riparian zones of the streams or by usurping other hydrologic features (e.g. wetlands).

Land Use

The greatest impacts on Chinook salmon/water quality occur with land development. Development (both private and public) often increases impervious surface. The degree of impact depends upon location, type and size of the development, construction methods and materials, and level of stormwater treatment.

Locations with potentially greater negative impacts include those adjacent to stream courses and in riparian buffer areas – essentially within the 200-foot stream corridor. Development resulting in stream crossings and structural encroachments can break riparian and buffer continuity and can also have negative impacts on streams. When this happens, species composition usually changes, sometimes quite radically. Similarly, removing trees and replacing native oak gallery forest with maintained lawns and non-native vegetation decrease a great many of the functions of a riparian system, especially those associated with water quality (temperature and filtering). Even a lawn, if compacted sufficiently, can act as an impervious surface, and the length of the grass may be too short to be effective as a filter strip, or as shade.

Development often causes the separation of streams from their floodplains, through methods to reduce property damage by flooding. As a result, runoff volume and velocity will increase, which can result in incising, sedimentation, and stream contamination. Streams are also constrained by infrastructure development such as streets and culverts. These barriers may increase the negative impact to Chinook salmon/water quality by restricting access, although this likely doesn't occur in Corvallis.

Impacts to Chinook habitat and water quality vary among different land uses, such as residential, industrial, commercial. Residential low-density housing can impact Chinook habitat through yard-maintenance activities, whereas higher residential density may have greater impervious surface runoff. Industrial land use whether heavy or light can impact Chinook salmon habitat. There may be greater potential for chemical contamination from these activities. The degree of impact from commercial land use depends in part on the size of the development and mitigation steps taken (either required or voluntary) to avoid, minimize or reduce these impacts.

Land Use Planning and Development Code

The Comprehensive Plan for the City of Corvallis serves to organize city development activities. It contains a vision of the future for its jurisdiction. Among the plan elements are goals and policies that guide future land development, development intensity and spatial distribution of activities, and the preservation and protection of resources such as waterways, riparian zones, forest, and significant wetlands.

The LDC helps to implement the Comprehensive Plan. At this time the LDC does not sufficiently addresses protection and preservation of habitat, riparian corridors, open spaces, and significant natural features that the Comprehensive Plan addresses. The Comprehensive Plan and LDC are currently out of sync. That is, the Plan identifies goals and policies that outline an approach, which could improve Chinook salmon habitat/water quality, but the LDC does not yet provide the specific language to implement the Plan. The LDC does address, though inadequately, some of the relevant habitat issues. The LDC will be updated after both the City's Statewide Goal 5 project effort and this ESA Salmon Response Plan are completed.

Citizen Behavior

There are citizen behaviors and activities that are identified and associated with water quality. Not all the activities have the same degree of impact, but they can result in stream contamination and further contribute to Chinook salmon habitat degradation. The following list represents some of these activities:

- Upkeep and maintenance of landscapes and yards. Activities such as mowing, pruning and improper disposal of yard debris can impact streams;

- Application of chemical insecticides, herbicides and fertilizers to landscape vegetation;

- Auto maintenance in driveways where oil, fluids and grease spills or improper disposal of these liquids can enter the streams;

- Excessive irrigation can wash contaminants into streams;

- Wash down of impervious surfaces; and

- Replacement of native with non-native vegetation.

CONCLUSION

It is clear from this examination that City activities, through any of the identified pathways, can have a negative impact on the streams in the project area. The greatest impacts come from impervious surface, followed by riparian buffer changes and stream channelization. Impervious surface results not from just the construction of buildings, streets, and parking areas, but also from such seemingly benign activities as trails, lawns, and parks. Stormwater runoff from urban development in the upper reaches of Corvallis streams (Dixon, Oak, and Dunawi) is likely to have the greatest negative impact on water quality. The lower reaches of these streams are already incised while the upper reaches still retain a great deal of function and hydrologic connectivity. This may change as these areas experience development and increases in impervious surface that will accelerate stream incision, diminish buffer and riparian connectivity, and channel larger volumes of water at higher velocities downstream.

The City has examined and identified City activities and citizen behaviors that negatively affect Chinook salmon habitat/water quality. They understand their impacts and spatial distribution. In the next chapter pro-active steps are identified that the City proposes to take to avoid, minimize or reduce the negative impacts and where possible reverse or improve Chinook salmon habitat and water quality.